IDEA GROUP PUBLISHING

701 E. Chocolate Avenue, Hershey PA 17033-1240, USA
Tel: 717/533-8845; Fax 717/533-8661; URL-http://www.idea-group.com

ITB8715

Chapter 26

Electronic Business Over Wireless Device: A Case Study

Richi Nayak
Queensland University of Technology, Australia

Anurag Nayak
IT Consultant, Australia

ABSTRACT

Research and practices in electronic businesses over wireless devices have recently seen an exponential growth. This chapter presents the basic concepts necessary to understand m-business applications and a case study of the voice driven airline-ticketing system that can be accessed at any time, anywhere by mobile phones. This application offers maximum functionality while still maintaining a high level of user convenience in terms of input and navigation.

INTRODUCTION

Research and practices in electronic business (e-business) have witnessed an exponential growth in the last couple of years (Huff, 2000; Liautand & Hammond, 2001; McKie, 2001; Wimmer, Traunmüller, & Lenk, 2001). At its broadest, e-business is any type of business transaction or interaction in which the participants operate or transact business or conduct their trade electronically.

Over the last decade, deployment of wireless communications in Asia, Europe, and North America has also been phenomenal (Boyd & Park, 1998; Garg & Wilkes, 1996; Shafi, 2001; Schneiderman, 1997). Wireless technology has evolved a logical path, from simple first generation analog products designed for business use, to second generation digital wireless telecommunications systems for residential and business environments, to emerging radio-active signal-based third generation of wireless communications.

The explosive growth of mobile computing and e-business has created a new concept of mobile electronic business or electronic business over wireless devices (m-business).

Mobile e-business is a new way of advertising, buying, selling and, in some cases, delivering goods and services. It includes a range of online business activities, business-to-business and business-to-consumer, for products and services through wireless devices such as mobile phones with display screens, personal digital assistant (PDA), two-way pagers, and low-end or reduced size laptops.

Significant benefits of m-business to consumers are convenience, portability, safety, integrating existing mobile phones with mobile computing technology, verifiable receipts and transaction records that can be made available instantly and permanently on the smartcard (Inglis & Mosely, 2000; Keller, Zavagli, Hartmann, & Williams, 1998). Significant advantages of m-business to service providers and/or content providers include driving additional revenue and decreasing consumer attrition by offering new m-business services.

This chapter presents a case study of an airline ticketing system, which can be accessed by users via a mobile phone voice browser. The specific goals for this system are to allow users to search for flight information and then purchase an airline ticket to a destination while still being mobile. The objective of this chapter is to present this m-business case study in detail. Before presenting this case study, the desirability of development of m-business applications is discussed.

BASIC CONCEPTS OF M-BUSINESS

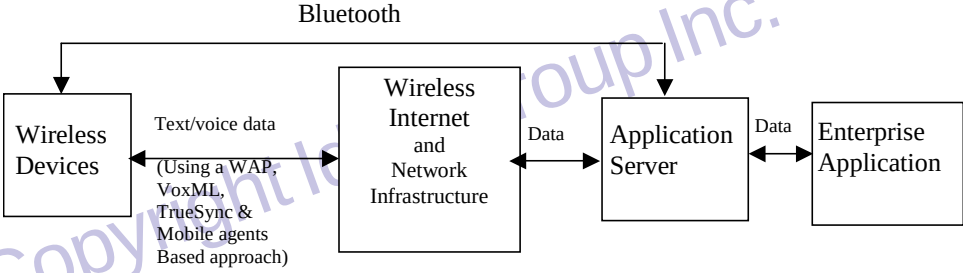
The applications and services that were envisioned for the m-business marketplace are becoming a reality today. Example applications are mobile ticketing and receipting, banking, mobile gaming, mobile weather forecast, sport scores access, movie database access, television guide access, stock exchange information, ordering of books and other daily needs such as food and groceries. Widespread adoption of m-business proves to be a more efficient mode of doing business. Figure 1 illustrates a typical platform that enables m-business services.

Technologies to Enable M-Business

The Internet standards require large amounts of (mainly) text-based data to be sent over the network. These standards are inefficient over mobile networks due to constraints such as low bandwidth, low computing processing, instable connection, etc. (Tsalgatidou, Veijalainen, & Pitoura, 2000). Techniques and protocols are required to conduct e-business for the unique constraints of the wireless computing environment.

Wireless Application Protocol - A commonly used approach to bridge the gap between e-business and mobile computing environments is Wireless Application Protocol (WAP).

Figure 1: A typical platform enabling m-business services



WAP makes it possible to link wireless devices to the Internet by optimising Internet information so it can be displayed on the small screen of a portable device.[1]

There are many components to WAP - the client, the gateway, and the server. The client is a person using a WAP-enabled mobile portal, a device containing a WAP browser much like Internet Explorer for a PC. A WAP gateway is an intermediary between the Internet and the mobile network. It converts WAP requests into Web (HTML) requests when information is requested from a mobile device and vice versa. A standard WAP server can be a HTTP Server capable of delivering wireless markup language (WML) files. Web pages accessed by WAP-enabled mobile portals during m-business transactions must be written in WML.[2] Characteristics of WML, based on XML principles, such as simplifying download times and presentation of web sites on mobile portals, make it most appropriate for developing applications.

It is not sure how well WAP will be able to proliferate (Tsalgatidou et al., 2000). Developments such as third-generation mobile communications and XYPOINT WebWirelessNow applications (Wen, 2001) already allow mobile phone users to experience the web services without WAP.

VoxML - Wireless Internet connecting technologies that offer textual interface, e.g., WAP, significantly suffer from the constraints of wireless communication such as having small display screen, less computation power, etc. An alternative solution is to provide voice access to users for the contents available on web via wireless Internet and network infrastructure. Advances in speech recognition and text-to-speech technologies have made voice-based communication possible between computers and users over the phone.

The voice access to web contents can be achieved by using an Interactive Voice Response system. Historically these systems have been very proprietary and therefore unsuitable for allowing access to web-based content. A better solution is to write web scripts in voice markup languages and follow the same development model as traditional web-based development. Existing markup languages (even with style sheets) are not well suited for developing voice dialogues. Even with sophisticated speech synthesis (using text-to-speech technology), it is not practical to read web pages developed for typical graphical browsing on the web. The free-form input elements of HTML forms do not align well with rigid telephone-grade speech recognition. For these reasons VoxML,[3] based on the W3C XML standard, is designed to support interactive dialogues. VoxML masks the technology behind the voice-to-voice communications by using XML data-tagging structures to link the text-to-speech that generates audio with the speech-recognition software that interprets a user's command (2001).

VoxML technology enables the application interface to be in the form of dialogues; navigation and input is produced via automatic speech recognition of end-user's voice; and output is delivered via text-to-speech software and recorded voice. For example, a user calls a VoxML server from a phone over an ordinary voice call. The user's own voice is actually data in this system. On the server, gateway translates the user's voice input, retrieves requested information from voice-enabled web sites via HTTP, performs actions based on the interpreted VoxML page, and can also read the relevant data (from the VoxML page) to the end user (2001).

There are some obvious drawbacks of this technology. There is extra overhead for content providers to offer the same web service through different channels, e.g., providing voice-enabled browser for their wireless customers along with the HTML/XML/WML browser. A manageable architecture using XML can solve this problem (2001). Another overhead is the processing power that speech recognition requires. The increasing CPU

speed is the solution of this problem. Also this type of data transfer mode is not appropriate for applications with confidential data where one could be overheard. Overall the success of this technology depends on public acceptance of mobile phones as data delivering tools and type of applications best suited to its use.

Bluetooth - The Bluetooth technology[4] further enhances the sphere of mobility by conducting m-business without a heavy network infrastructure unlike WAP and VoxML technologies. The Bluetooth technology is designed to allow low-cost, short-range data (asynchronous) and voice (synchronous) radio link (2.4 GHz, 1 Mb/sec) to facilitate protected connections for stationary (homes, buildings, shopping centres, restaurants, cars, etc.) and mobile (phones, PDAs) computing environments. A simple example of a Bluetooth application is to automatically update mobile phone contents such as phone list, emails and memos without any user involvement when the phone comes within the range of the home/office PC.

The Bluetooth technology allows for the replacement of the many proprietary cables that connect one device to another with one universal short-range radio link.[5] The Bluetooth networks providing m-business services are limited to 30 feet only. A promising future of Bluetooth technology is its integration with WAP or VoxML. Some work in this direction is currently under way.[6]

TrueSync - The TrueSync technology is an approach providing a complete customised SyncML-enabled synchronization and integration of infrastructure and software solutions for wireless and wired devices. The TrueSync technology platform is designed to: (1) provide multi-point synchronization - one-step synchronization of wireless and wired devices, desktop applications and server-based applications and servers; (2) allow users to enter information once anywhere, and synchronize it everywhere; (3) enable the rapid development of ultra-thin, wearable products without sacrificing performance or quality; (4) optimise battery life and memory requirements of wired and wireless devices; (5) integrate with the new digital wireless infrastructure; and (6) operate seamlessly with standard enterprise software applications.[7]

Mobile Agent Paradigm - Mobile agent technology offers a new computing paradigm in which a program, in the form of software agents, initiated at the host, can suspend its execution on a host computer, launch itself to another agent-enabled host on the network, resume execution on the new host, and return back to its host with the result (Cockayne, 1998; Hayzelden & Bigham, 1999; Rothermel & Hohl, 1998).

This type of paradigm advocates the client/server model where the client is a mobile portal and server is a fixed network. The server hides the vendor-specific aspects of its host platform and offers standardized services to a mobile agent that is migrated to such a server from its mobile portal host. The mobile agent performs various optimisations on the server in lieu of its mobile portal to reduce the problems such as C-autonomy, limited bandwidth, and limited computational power. The fixed network offers its services to the agent, such as access to local resources and applications, the local exchange of information between agents via message passing, basic security services, creation of new agents, etc.

Many research papers emphasis that one of the most promising approaches for developing e-business applications is mobile agent technology (Dikaiakos & Samaras, 2001; Tsalgatidou et al., 2000). Influenced with this success, m-business applications supported by personalized agents (such as search agents to locate appropriate service around a geographical location) do not seem to be far away from realization. Such agents in m-business environments are initiated at the mobile host, migrated at the fixed network to perform a specified task, and return to the mobile host with the result.

Technical, Business and Legal issues in m-business and their ramifications

Analysing demands and opportunities in increasing revenue, network operators and companies have started offering m-business services to mobile subscribers. Innovative applications such as news, travel, mobile banking, etc., have been developed to attract subscribers. However, it is not easy to develop m-business applications due to some technical and legal issues involved.

Limited environment of mobile device - From the technical point of view, the mobile devices are a limited environment for user convenient purposes. These devices usually have limited display size, limited input capabilities, limited data transfer rate, limited computation power, limited power usage, etc.

Application partitioning can be effectively used over a wireless link to deal with these limitations. Much like a client/server application design, the application and its functionality are divided into two separate interacting parts. How much of the application is run on the client side versus the server side can be decided dynamically based upon the available bandwidth. Another solution to reduce the need and amount of transferring unnecessary data to consumer is locating the position of the consumer and then, sending only the most relevant information to that current geographical location (Pfeifer, Magedanz, & Hubener, 1998; Ratsimor, Korolev, Joshi, & Finin, 2001; Terziyan, 2001). This eliminates the need of burdening mobile users with extraneous information for services in remote locations.

Security - Consumers should feel the same sense of security when they shop using a mobile phone, as when they shop in the physical world. Two approaches, Secure Sockets Layer (SSL) and Secure HTTP (SHTTP), that provide secure electronic cash transactions for e-business by encrypting all web network traffic, do not apply in m-business applications (Freier, Karrton, & Kocher, 1996). There are some problems using these protocols, such as: (1) these protocols cannot generate signed messages or signed receipts, which naturally makes them unsuitable for electronic online payment and contract signing tasks; (2) these protocols do not allow WWW browsers to tell users in a simple way with whom exactly they are communicating over an establishes secure channel; (3) mobile portals may not have efficient encryption algorithms installed due to limited computing processing and input storage; and (4) the mobile portal and the content provider may not be using the same security protocol. In this case, gateway server requires the message to decrypt and encrypt again, and the message resides on the server in its original form for sometimes. (Chari, Kermani, Smith, & Tassiulas, 2001; Lacoste, Pfitzmann, Steiner, & Waidner, 2000)

There are various encryption and integrity mechanisms available to protect digitally encoded speech and control information in m-business services. Once a shared secret key is established between two entities across an interface (such as a mobile portal and a fixed network server), protocols dealing with transactional requirements for the business model deployed in m-business applications are responsible for authenticating the entities involved.[8]

Identification is another issue that is related with m-businesses, as mobile devices are prone to be stolen. Usually a person using m-business services is identified with an SIM card or device identity. Although the device is protected with security PIN, what if the device is stolen while on or along with its PIN, which is usually the case. Identification can be based on personal identity such as finger or eye prints or voice recognition (easy and preferred method if VoxML is used.

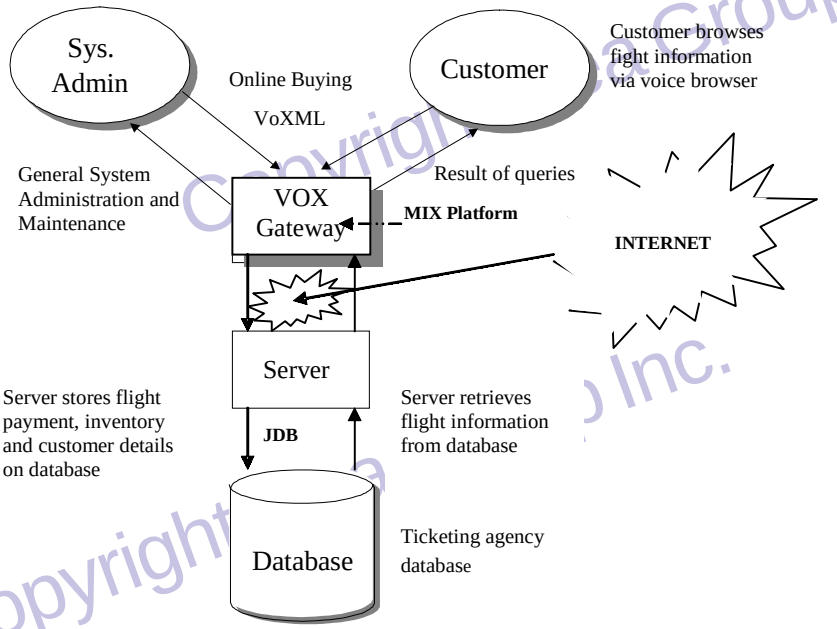
Transactional issues - Usually transactional models with Atomicity, Consistency, Isolation and Durability problems (ACID) assist an application developer in providing powerful abstraction and semantics to concurrent executions and recovery in transaction management. M-business transactions require these properties to be redefined due to additional requirements such as (1) the need for transferring money and goods along with data transfer, and (2) increased risk of incomplete transactions as mobile terminals can easily lose network connections (C-autonomous).[9] Approaches such as the asymmetric cryptographic algorithms (also called Public Key algorithms) with certification authorities are used to fulfil ACID properties of m-business transactions (Tsalgatidou & Veijalainen, 2000; Veijalainen, 1999).

Legal issues - From the legal point of view, consumers' mobility poses new challenges. Every country has its own legislation about conducting e-businesses. A consumer may be in USA while doing a business transaction in Europe with his/her mobile portal. The question arises that the business should be conducted according to which legislation - legislation of the residence country of the content provider, or the service provider, or the consumer. This problem calls for restructuring the m-business conducting regulatory framework worldwide. The geographical location of mobile users can be identified and used in charging for m-business services according to an appropriate legislation. (Tsalgatidou & Veijalainen, 2000; Veijalainen, 1999)

A CASE STUDY

This section describes a case study that allows users to search for flight tickets and to purchase online using voice-driven mobile portals. Instead of using HTML (or WML) pages to browse flight information, users will be interacting with the web site through a voice browser.

Figure 2: The Voice-driven airline-ticketing system (a simple presentation)



Main Components

The Voice-Driven Mobile Airline-Ticketing System illustrated in Figure 2 consists of four main components: User, Gateway, Application Server, and Application Database. This m-business application is developed using Mobile Application Development Kit (MADK 2.0).[10] Following is the description of components of this application.

VOX (Voice) Gateway - MIX Platform - The Mobile Internet Exchange Platform[11] (MIX communications platform) offers capabilities ranging from voice dialling of phone numbers to allowing a user to read or listen to Internet content or email while mobile. The MIX platform has two gateways to channel the type of information coming into the gateway server. When the server detects incoming data-based information, the Wireless Application Protocol

```
<?xml version=”1.0"?>
<!— Prototype Source Code —>
<DIALOG>
<CLASS NAME=”help_generic”>
<HELP> Your choices are <OPTIONS/>. </HELP>
<ERROR TYPE=”ALL”> Your choices are <OPTIONS/>. </ERROR>
</CLASS>
    <!—  MOVING TO “init” step  —>
<STEP NAME=”init”>
<PROMPT>
This is an example of what a voice driven ticketing application
might sound like.
</PROMPT>
<INPUT TYPE=”NONE” NEXT=”\#intro”/>
</STEP>
    <!—  MOVING TO “intro” step  —>
<STEP NAME=”intro” PARENT=”help_generic”>
<PROMPT>
Hello, and welcome to <BREAK MSECS=”250"/> The voice driven airline
ticketing system. <BREAK MSECS=”250"/> Please say your name or say Main
Menu to return to the main menu.
</PROMPT>
<INPUT TYPE=”OPTIONLIST” NAME=”userName”>
<OPTION NEXT=”\#userGreeting” VALUE=”Richi Nayak”> Richi Nayak </
OPTION>
<OPTION NEXT=”\#top.vml\#top”> main menu </OPTION>
</INPUT>
</STEP>
        <!—  MOVING TO “userGreeting” step  —>
<STEP NAME=”userGreeting”>
<PROMPT>
Welcome <VALUE NAME=”userName”/>
</PROMPT>
<INPUT TYPE=”NONE” NEXT=”\#pid”/>
</STEP>
</DIALOG>
```

(WAP) gateway activates. Likewise, when voice-based information is detected, the VOX (voice) gateway is activated.

We utilize the VOX gateway to transfer the message (voice) between the mobile phone and the fixed network server. The scalability, reliability, security, and performance of this application depend on the protocols implemented in MIX platform. An example VoxML script that allows interactions with users is:

Application Server - The application server is a communications module between the ticketing agency database and the user. The server performs the following tasks: (1) receives the VoxML request, retrieves search information and returns it to the user, and (2) receives purchase information, such as user details, relevant flight and payment details, while monitoring seat inventory.

This case study uses JRUN of j2ee application server for implementation. With its modular design, JRUN is especially suitable for the development of e-business applications using Java Server Pages and Java Servlets, among others. The alternative solution can be ORACLE 9ais, BEA WebLogic, IBM WebSphere application server, etc. The developed application mainly depends on server-side processing in developing dynamic pages as client-side processing is considered to be slow and not advantageous looking at the limited environmental characteristics of mobile portals.

Database - The foundation of the developed application relies on the database (currently implemented as a dummy database) underneath in which it uses server side processing and an interface between the server and the database in generating dynamic pages for the voice browser of the client.

System Operation

In this system, a user requests a flight status for a specific flight by making a phone call to an online service provider and logging into the system. Upon connection, the user is presented with a dialog sequence stating a range of voice-driven services provided. The user selects the type of service, in this case, "flights information," which allows the user to either search for flight information and /or book a flight and/or purchase an airline ticket. The voice browser recognizes the voice request and translates it into a URL for a travel service provider's Web application server. The Web application server processes the request to determine the status for the specified flight, as it would process a request from a Web browser, and responds with a VoxML page. The voice browser interprets the VoxML page to relay flight information to the user via audio voice.

Depending on the results of the search, the user can either repeat a search query or move on to another search sequence. If search information matches the user's preferred flying schedule, the system will then prompt the user to confirm acceptance and finalize ticket purchase by making a permanent reservation. When the user selects to make and pay for a booking, the system prompts the user to complete the transaction by providing credit card details. The system then interacts with the financial institute to validate cardholder details and verifies funds. Once successful, the system credits the cardholder with the airfare and then executes a credit entry into the system's bank account. The system then allocates a new booking number and inserts the booking into the database. On completion, the system allocates a passenger number. Together with the booking number, the system inserts passenger details into the database. The interaction is transparent to the user, much like surfing the Web is via the computer on a desk today.

The user interface of the project is implemented through the User Interface Simulator (UIS) of the Motorola Mobile Applications Development Kit, a speech agent, that speaks dialogs written within VoxML tags, and a transcript window that displays the interchange between the user and the system. Figure 3 illustrates each component of this case study in detail.

System Benefits

The system enables users to search for flight information and reserve/buy airline tickets anytime, anywhere. The application offers maximum functionality while still maintaining a high level of user convenience in terms of input and navigation. Most of the computing processing is on server side. Also, the use of VoxML technique enables the user to interact with mobile portals through voice browser. Otherwise, the user convenience (implementing user interface menu using HREF anchor tags and back buttons of WML) is compromised because of the small display screen of a mobile device environment.

RELATED WORK

A number of public and private initiatives are underway to offer efficient m-business services to customers worldwide. The Global Mobile Commerce Forum (GMCF)[12] was established in 1997 by a diverse group of companies from around the world to promote the development of mobile commerce services around the world, for the benefit of consumers and the companies involved. The Wireless Data Forum (WDF)[13] was established in 1999 to help the wireless industry develop new e-business products and services and to use the Internet to sell products and services.

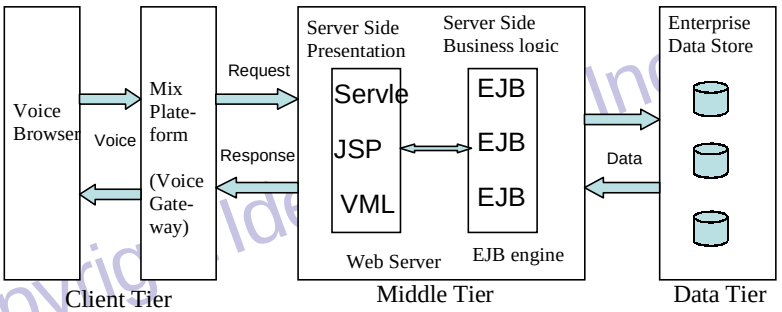
As there are not many m-business applications using VoxML, attempts have been made to search voice-activated business applications on the Internet or high quality WAP applications related to the air-line system explained in this chapter.

Voice Activated M-Business or E-Business

A handful of businesses are using VoxML or equivalent (VoiceML or IBM's SpeechML) techniques to provide voice-enabled services.

One such business is Tellme Network[14] that combines the power and flexibility of open Internet standards with world-class voice recognition technology. The Tellme Voice Application Network combines carrier-grade Network Infrastructure, the premier VoiceXML Application Platform, and the Voice Advantage suite of unique voice technologies. The

Figure 3: The Voice-driven airline-ticketing system (A detailed presentation).



company claims that (1) the voice applications can be deployed up to 90% faster than with traditional voice-enabled IVR systems, and (2) voice applications are at scale, easy, and cost-effective for businesses to give their customers self-service access to powerful voice-activated applications any time from any telephone.

Another such business is BeVocal[15] creating voice portal applications that can be personalized based on a caller's location, delivered to any device, and customized. BeVocal's applications and tools utilize the BeVocal Foundation Platform that supports both the VoiceXML 1.0 and Java standards for delivering voice-enabled enhanced services. BeVocal's voice-activated applications enable callers to use simple spoken commands and keywords to access location and travel services, information services, and entertainment services.

America Online's new AOLbyPhone[16] service provides access to its members to their AOL account from any phone, anytime, anywhere, simply by speaking. This system also provides facilities like getting movie listings, bar/restaurant guides, news, stock quotes, sports scores and international weather updates. The AOL/Quack voice platform utilizes voice recognition technology provided by SpeechWorks International and its Speechify's Text-to-Speech engine.

Related WAP Applications

There are a number of Internet sites with WML browser. Following are some of the high quality WML Internet sites in terms of user convenience.

Qantas Airways[17] offers information such as providing real-time flight timetables to users with mobile devices. This site mainly implements drop-down menu and back button for the site navigation. This site attempts to offer the user text input to search for flight numbers.

Weather Online[18] offers comprehensive current weather and forecast information worldwide. Navigation on the site is provided using HREF anchors and the options and previous buttons. No user text inputs seem to be available, and thus site navigation is straightforward, choosing the anchors provided.

Go2Online[19] offers a wide range of services such as the directory/location service (in terms of distances, street names, etc.) for restaurants, cinemas, shops, etc. inside the United States to mobile users. Navigation is mainly done using the options button and anchor tags on a single card.

Microguides[20] offers guidance (in terms of basic contact information of address and phone numbers) to specific important places such as consultants, hospitals, hotlines, etc worldwide. Navigation on this site is pretty straightforward, using many HREF anchor tags, and pages on this site load faster.

Most of these sites use databases and server-side processing to dynamically generate WML pages. Overall, these sites are capable of satisfying users needing relevant information considering the limitations of wireless applications.

SUMMARY AND CONCLUSION

This chapter attempts to present the basic concepts and issues associated with m-business. This chapter also discusses a working prototype of a voice-driven airline-ticketing system. This system allows consumer to use the service with voice browsing. This improves the value of the service for the providers and gives an easy and natural interfacing and interacting to the users with mobile portals. Considering it is difficult to provide full convenience due to the limited nature of the wireless devices, the application seems to be able to offer ease of navigation in providing real-time flight timetable information to users of

mobile devices, anytime and anywhere. We are currently working on improving this system. We are expanding our knowledge base of airline tickets. We are also looking into making this system more distributed and fault tolerant.

Many optimists see m-business as a technology that is just one step away from becoming everyday use. Analyst and consulting company, Ovum Limited, predicts that the market potential for m-business in Asia-Pacific is expected to hit US$67 billion in 2005 (Businessworld, 2001), where it is highly adopted as compared to Europe or North America. Many pessimists see many unsolved problems and predict that m-business will not break through in the next few years (Martin, 2001). As usual, the truth lies somewhere in the middle.

Basic techniques are already available. Millions of people are already using mobile portals. Businesses are making profits—by moving on to e-business solutions. The potential of m-business is enormous. So why not integrate them all? Major mobile service providers are taking initiatives (such as MeT[2,1] GMCF, WDF) to make this technology flourish. The remaining tasks are rigorous testing and refining of protocols especially suited for m-business applications, and resolving the related technical, business, and legal issues, thus winning the trust of consumers to use m-business services.

ACKNOWLEDGMENT

First, we would like to thank Ameesh Baxi and Giri Selvaduri for their valuable time to implement this case study with us. We also wish to thank Nevill Inglis, Madhav Shivdas, and Andrew Boey from the e-commerce and smart card group at Motorola Application Software Centre, Adelaide, Australia, for their technical assistance. Finally, we would like to thank Jill Slay and the School of Computing and Information Science, University of South Australia, Adelaide, for providing us resources.

REFERENCES

Boyd, C. & Mathuria, A., (1998). Key establishment protocols for secure mobile communications: A selective survey. In *Information security and privacy*, Vol. 1438 of *Lecture Notes in Computer Science*, 344-355. New York: Springer-Verlag.

Boyd, C. & Park, D., (1998). Public key protocols for wireless communications. In *Proceedings of the 1st International Conference on Information Security and Cryptology* (ICISC 98), 47-57.

Businessworld (2001)., Visa Int'l launches secure mobile. In *Financial Times Information Limited*, Manila. October 1.

Chari, S., Kermani, P., Smith, S., & Tassiulas, L., (2001). Security issues in m-commerce: A usage-based taxonomy. In Liu, J. & Te, Ye. (Eds). *E-Commerce agents*, vol. 2033 of *Lecture Notes in Artificial Intelligence*. 264-282. New York: Springer-Verlag.

Cockayne, W. R., (1998). *Mobile agents*.

Dikaiakos, M. D. & Samaras, G., (2001). Performance evaluation of mobile agents: Issues and approaches. In R. Dumke et al., (Eds). *Performance Engineering*, volume 2047 of *Lecture Notes in Computer Science* 148-166. New York: Springer-Verlag.

Freier, A. O., Kartton, P., & Kocher, P. C., (1996). The SSL protocol version 3.0. Technical report, *IFTF Transport Layer Security Working Group*.

Garg, V. & Wilkes, J. E., (1996). *Wireless and Personal Communications Systems*. Upper Saddle River, NJ: Prentice Hall.

Hayzelden, A., & Bigham, J., (1999). *Software agents for future communication systems*. Berlin; New York: Springer-Verlag.

Huff, S. L. (2000). *Cases in electronic commerce*. New York: McGraw-Hill.

Inglis, N. & Moseley, P., (2000). Towards secure e-commerce over wireless devices. Technical report, *Motorola Application Software Centre*, Adelaide, Australia.

Keller, R., Zavagli, G., Hartmann, J., & Williams, F., (1998). Mobile electronic commerce: GeldKarte loading functionality in wireless wallets. In *International IFIP/GI Working Conference: Trends in Electronic Commerce*, Hamburg.

Lacoste, G., Pfitzmann, B., Steiner, M. & Waidner, M., (Eds.) (2000). *SEMPER - Secure electronic marketplace for Europe*, vol 1854 of *Lecture Notes in Computer Science*. New York: Springer Verlag.

Liautaud, B. & Hammond, M., (2001). *E-business intelligence: Turning information into knowledge into profit*. New York; London: McGraw-Hill.

Martin, Z., (2001). Mobile commerce is coming, but experts can't say when. *Card Marketing, 5*(8). October 3. New York: Thomson Financial.

McKie, S., (2001). *E-business best practices: Leveraging technology for business advantage*. New York; Chichester: Wiley.

Pfeifer, T., Magedanz, T., & Hubener, S., (1998). Mobile guide - Location-aware applications from the Lab to the Market. In *Lecture Notes in Computer Science*, vol. 1483, 15-28. New York: Springer-Verlag.

Ratsimor, O., Korolev, V., Joshi, A., & Finin, T., (2001). Agents2Go: An infrastructure for location-dependent service discovery in the mobile electronic commerce environment. In *ACM Mobile Commerce Workshop*. Retrieved October 5, 2001, from citeseer.nj.nec.com/455113.html.

Rothermel, K. & Hohl, F. (Eds.)., (1998). *Mobile agents: Second international workshop*. Berlin; New York: Springer. Stuttgart, Germany, September 9-11.

Schneiderman, R., (1997). *Future talk: The changing Wireless game*. New York: IEEE Press.

Shafi, M., (2001). *Wireless communication in the 21st century*. New York: John Wiley-IEEE Press.

Terziyan, V., (2001). Architecture for mobile p-commerce: Multilevel profiling framework. In IJCAI 01 *Workshop on E-business and the Intelligent Web*.

Tsalgatidou, A. & Veijalainen, J., (2000). Mobile electronic commerce: Emerging issues. In *Proceedings of 1st International Conference on E-commerce and Web Technologies* (EC-Web), London-Greenwich, U.K.

Tsalgatidou, A., Veijalainen, J,. & Pitoura, E., (2000). Challenges in mobile electronic commerce. In *Proceedings of 3rd International Conference on Innovation through E-commerce* (IeC). Manchester, UK.

Veijalainen, J., (1999). Transactions in mobile electronic commerce. In *Transactions and Database Dynamics*, volume 1773 of *Lecture Notes in Computer Science*. G. Saake, K. Schwarz, & C. Trker, (Eds.). New York: Springer Verlag.

Wen, H., (2001). Doing the Web without WAP: A Discussion with XYPoint's Patrick Carey. In *The Wireless Communication Channel*. Retrieved October 1, 2001, from http://www.wirelessdevnet.com/channels/lbs/features/xypoint.html.

Wimmer, M., Traunmüller, R., & Lenk, K. (2001). Electronic business invading the public sector: Considerations on change, and design. In *Proceedings of the 34th Annual Hawaii International Conference on System Sciences*.

The wireless communication channel (2001). . Retrieved October 1, 2001, from http://www.wirelessdevnet.com/channels/voice/training/voicexmloverview.html.

ENDNOTES

[1] Edited and retrieved, September 28, 2001 from http://www.wapforum.org/

[2] Edited and retrieved, September 25, 2001 from http://www.oasis-open.org/over/wap-wml.html

[3] http://voxml.mot.com/

[4] http://www.bluetooth.com

[5] Edited from "Technology Overview", retrieved October 1, 2001 from http://www.bluetooth.com/v2/document

[6] http://www.wapforum.org/

[7] Edited from "Technology Overview", retrieved October 1, 2001 from http://www.starfish.com/products/truetech/truetech.html

[8] Several security protocol improvements exist but this discussion goes beyond the scope of this chapter. Secure Electronic Transactions (SET) [http://www.setco.org/] is probably the best-known commercially developed standard. Interesting readers can refer (Boyd & Mathuria, 1998; Chari et al., 2001) for detailed study of security issues in m-business.

[9] Interesting readers can refer (Veijalainen, 1999) for a detailed study of transaction issues in m-business.

[10] http://www.motorola.com/MIMS/ISG/cgi-bin/dev_madk_wp.cgi

[11] http://mix.motorola.com/

[12] http://www.gmcforum.com/

[13] http://www.wirelessdata.org

[14] http://www.tellme.com

[15] http://www.bevocal.com/index.html

[16] http://www.quake.com

[17] http://www.qantas.com.au/wap/dyn/Main

[18] http://wap.weatheronline.co.uk

[19] http://wap.go2online.com

[20] http://www.waptown.net/main.wml

[21] MeT, http://www.mobiletransaction.org/, targets to establish a framework for secure mobile transactions, ensuring a consistent user experience independent of device, service and network.